TERSILOCHINAE AS PARASITOIDS OF INSECT PESTS OF WINTER RAPE (HYMENOPTERA : ICHNEUMONIDAE)

Josef Šedivý

Research Institute for Crop Production
Praha-Ruzyně, ČSSR

Abstract

From 1951 to 1982, eight species of ichneumon flies of the subfamily Tersilochinae, were discovered which parasitize the coleopterous pests of winter rape in Czechoslovakia. Of these, only *Tersilochus fulvipes* Grav. showed a significant influence on the population dynamics of its host. The parasitization by the other ichneumon fly species was low and showed considerable variation in different localities even within one year. In large fields of winter rape, the parasitization of larvae of *Meligethes aeneus* decreased with increasing distance from the edge of the field. An electrical suction trap recorded only the dispersal of ichneumonid species dispersing above the tops on the winter rape plants. The dispersal was most intensive during morning hours and ceased during night hours. Yellow dishes were little attractive for most of the species.

The ichneumon flies of the subfamily Tersilochinae are common parasitoids of insect pests infesting winter rape (*Brassica napus* var. *arvensis*). *Tersilochus* spp. parasitize larvae of *Ceutorhynchus* spp. (Curculionidae), *Meligethes* spp. (Nitidulidae) and *Psylliodes chrysocephala* L. (Chrysomelidae). The members of the genus *Aneuclis* parasitize larvae of *Ceutorhynchus*., *Meligethes* and *Phyllotreta* spp. Two species of *Phradis* parasitize larvae of *Meligathes* spp. that damage winter rape or develop in wild-growing cruciferous and other plants. In the literature, most of the ichneumon flies have been long referred to under incorrect names. Aubert and Jourdheuil (1958) reported several species of Tersilochinae infesting insect pests of winter rape in France. Horstmann (1971, 1981) treated comprehensively the taxonomy of the European species of Tersilochinae and provided supplementary data on their hosts, distribution and time of occurrence. All species parasitize larvae of their hosts. Only Fritzsche (1956) observed *Phradis interstitialis* Thoms. to parasitize adults of *Meligethes aeneus* and *M. picipes*.

The present contribution supplements the knowledge of the bionomics of ichneumon fly species commonly occurring in cultivated fields of winter rape and evaluates their impact on the populations of their host pest species.

MATERIALS AND METHODS

During the growing seasons of 1951 to 1982, the occurrence of the ichneumon flies of the subfamily Tersilochinae was investigated in Czechoslovakia in winter rape fields in 1955 - 1957, 1966 - 1969, 1976 - 1976 and 1980 - 1982. The observations were largely made in the potato production areas specialized for growing winter rape. In them, the winter rape cultivation was about 8 - 12% of the total field crops. Only the observation area in Praha-Ruzyně is situated outside this area. The Ichneumonid species composition was evaluated from samples obtained by three times 50 strokes made by a sweeping net in winter rape cultures at the end of the flowering period. The samplings were taken from the western, central and southern parts of Bohemia

(Czechoslovakia). The host-parasite ratio (H:P) was evaluated from samples of the same size taken at weekly intervals from rape stands in which the occurrence of the ichneumon flies and their hosts was studied throughout the growing season. Parasitization of larvae of *Meligethes aeneus* was determined by the number of first instar larvae whose dark head capsule can be seen through the translucent epidermis of the host on its dorsal or ventral side. The differences in the degree of parasitization of larvae of *M. aeneus* at the edges and in the middle of rape fields from 10 to 120 ha in area was evaluated in the same way. The larvae were shaken out of rape flowers at distances of 5, 10, 25, 50, 100 and 200 m from the edge of the field. For this study, rape fields were selected which were at least approximately square in shape. The species of the ichneumon larvae within the host larvae was not determined. The degree of parasitization of larvae of *Ceutorhynchus napi*, *C. quadridens* and *C. assimilis* was determined by dissecting full-grown larvae at the end of the flowering period of winter rape. As for *C. pleurostigma* of the autumn strain, the dissections of the larvae were carried out in the spring months.

The daily flight activity of the ichneumon flies was studied using a small Johnson-Taylor suction trap placed in small experimental plots of winter rape in Praha-Ruzyně. The entrance opening of the suction trap was 1.2 m above the ground. The mechanism of this type of suction trap makes it possible to evaluate insect samples taken at intervals of 60 minutes. The occurrence of ichneumon flies on the phenophase of winter rape was studied using six yellow dishes placed in the same plots as in the case of the suction trap. The position of the dishes varied in the course of the growing season: they were gradually lifted so that their bottom was on the level with the tops of the rape plants.

RESULTS

Eight species of ichneumon flies are recorded here which parasitize winter rape pests of the order Coleoptera in the territory of Czechoslovakia. The periods of their occurrence, including findings outside winter rape stands, are given in Table I.

Depending on their occurrence in winter rape stands, those ichneumon fly species that are on the wing in March and April are the most decimated by insecticide treatment of the rape stands which is applied at that time. The stands bloom in May and early June at which time no insecticides are applied that could affect the occurrence of the parasitoids. Those species that occur in winter rape stands in June and early July may, in some years, be decimated by insecticide applications against overcrowded populations of the cabbage aphis (*Brevicoryne brassicae* L.) infesting winter rape pods.

Tersilochus heterocerus (Thoms.), **Phradis morionellus** (Holmgr.)

Adults of *T. heterocerus* occur together with *P. morionellus*. Suction trap samples, however, suggest that the period of occurrence of the latter species in winter rape stands is shorter than that of the former (Fig. 1). The parasitization of larvae of *M. aeneus* by both species varied in successive years as well as in different localities. In peak years of the pest and in the subsequent years the percentage parasitization was higher (Table II). As for

Table I. Periods of occurrence of ichneumon flies in winter rape stands and in natural habitats.

Species	Host	Period of occurrence
1. *Aneuclis incidens* (Thoms.)	*Meligethes aeneus* *M. viridescens*	28.IV. - 30.IX.
2. *Aneuclis melanarius* (Holmgr.)	*Ceutorhynchus pleurostigma* *C. assimilis* *Psylliodes chrysocephala*	5.V. - 28.VIII.
3. *Phradis morionellus* (Holmgr.)	*Meligethes aeneus* *M. viridescens* *M. symphyti*	16.IV. - 30.VIII.
4. *Phradis interstitialis* (Thoms.)	*Meligethes difficilis* *M. picipes* *M. viridescens*	18.V. - 17.VII.
5. *Tersilochus heterocerus* (Thoms.)	*Meligethes aeneus* *M. viridescens*	28.IV. - 6.VII.
6. *Tersilochus fulvipes* (Grav.)	*Ceutorhynchus napi* *C. punctiger*	12.IV. - 14.VI.
7. *Tersilochus obscurator* Aubert	*Ceutorhynchus quadridens* *Psylliodes chrysocephala*	1.IV. - 30.VI.
8. *Tersilochus tripartitus* Brischke	*Psylliodes chrysocephala*	29.III. - 12.V.

T. heterocerus, the H:P ratio showed considerable variation in successive years: it was 18.5:1 in 1955, 8:1 in 1956, 21.5:1 in 1957, 36.8:1 in 1981 and 20:1 in 1982.

Tersilochus fulvipes (Grav.)

This species was the dominant parasitoid of larvae of *C. napi*. During years of serious occurrence of *C. napi* the parasitization of the weevil larvae attained 79-98%. Since 1977 the occurrence of *C. napi* has never attained economically significant levels and the single larva found in rape stems were mostly parasitized. The high degree of parasitization of larvae of *C. napi* during years of their low numbers suggests a significant role of *T. fulvipes* in the regulation of their numbers (Table III). The abundance of adult *T. fulvipes* in winter rape stands was the highest in late April and early May and was unfavorably affected by intensive chemical control of adult *M. aeneus*. This species was absent from the catches in the suction trap. Occasional specimens were obtained from the yellow dishes in years of higher population densities of the host.

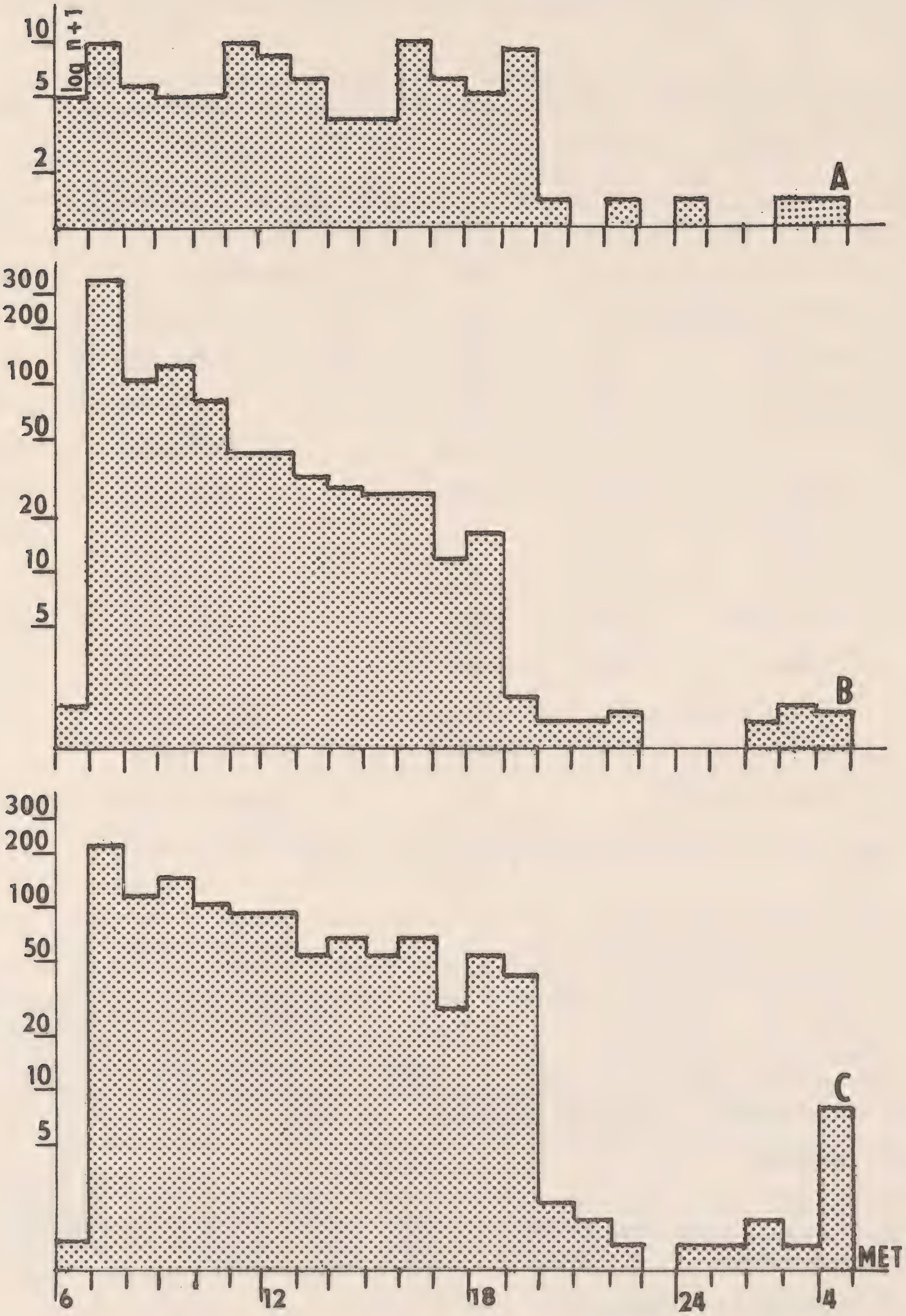

Fig. 1. Intensity of dispersal of ichneumon flies during 24 hours, as revealed by a Johnson-Taylor suction trap. A , **Tersilochus obscurator.** B, **Phradis morionellus.** C, **Tersilochus heterocerus.**

Table II. Parasitization of larvae of *Meligethes aeneus* (n = 300)

Date	Locality	No. ichneumonid larvae per one host larva (in %)					
		0	1	2	3	4	5
5.VI.55	Praha-Ruzyně*	12.-	10.1	21.1	25.6	10.5	20.6
30.V.56	Praha-Ruzyně	22.3	8.1	17.6	32.1	12.5	7.6
20.V.57	Praha-Ruzyně	10.-	17.-	60.2	0.8	9.3	2.7
12.V.66	Benešov	50.2	42.3	0.6	1.9	2.6	0.4
4.V.67	Benešov*	20.-	29.8	51.-		0.8	
22.V.69	Benešov*	98.-	1.8		0.2		
29.V.74	Benešov	92.3	1.6	6.-	0.1		
19.V.75	Benešov	94.-	6.-				
14.V.76	Tachov*	95.-	2.3	2.7			
28.V.80	Nový Bor*	16.-	59.2	21.-	3.3	1.2	0.3
30.V.	Tachov	42.1	48.6	6.3	3.-		
22.V.81	Praha-Ruzyně	47.-	51.1	1.9			
9.VI.	Slapy	61.2	39.1	0.7			
28.V.82	Praha-Ruzyně*	23.-	15.-	6.-	11.7	41.4	2.8

*Peak years of *M. aeneus*, attaining economic level.

Tersilochus obscurator Aubert

The females infest 3rd instar larvae of *C. quadridens*. In 1955 through 1982, the parasitization determined in 18 randomly selected stands varied between 6 and 69%. During 1982 in five observation sites, the parasitization varied within the range of 12 - 31%. The importance of this parasitoid for the population dynamics of the host was small as the percentage parasitization was low and considerably variable (Table IV).

Aneuclis incidens (Thomson)

During the study years the occurrence of this species was sporadical in the winter rape stands. No occurrence was recorded for 1975, 1980-82. The species is abundant on cruciferous weeds during summer.

Aneuclis melanarius (Holmgren)

The species was currently reared from the autumn strain larvae of *C. pleurostigma* and occasionally also from those of *C. assimilis*. Their infestation was invariably very low and did not affect the numbers of the host species.

Table III. Parasitization of larvae of *Ceutorhynchus napi* by *Tersilochus fulvipes*

Date	Locality	No. larvae of *C. napi*	H:P	No. larvae parasitized by *T. fulvipes*
5.VI.55	Praha-Ruzyně*	100	58.1:1	88
30.V.56	Praha-Ruzyně	62	2.6:1	60
20.V.57	Praha-Ruzyně	12	2.6:1	10
12.V.66	Benešov	39		33
4.V.67	Benešov	18		8
22.V.69	Benešov*	100		79
29.V.74	Benešov*	100	18.1:1	82
19.V.75	Benešov	32		26
14.V.76	Tachov	100		89
28.V.80	Nový Bor	23		18
30.V.80	Tachov	10		9
22.V.81	Praha-Ruzyně	1	1.5:1	1
9.VI.	Slapy	2		2
27.V.82	Praha-Ruzyně	1		0
4.VII.	Praha-Ruzyně	1	1.3:1	1
5.VII.	Tachov	2		2

*Occurrence of *Ceutorhynchus napi* above the economic level.

Phradis interstitialis (Thomson)

This species has been found to occur in warm years and in weedy cultures of winter rape (1955, 1976, 1982). Attempts at rearing this species from larvae of *M. aeneus* have been unsuccessful. The occurrence of this species coincided mainly with the end of flowering period of winter rape.

Tersilochus tripartitus Brischke

The species is common in winter rape stands only in years of serious occurrence of *Psylliodes chrysocephala*. It occurred in rather large numbers only in 1955 and 1956. In 1956, an economically important occurrence of its host, *P. chrysocephala* , was recorded. The H:P ratio was 16.2:1. In the subsequent year the abundance of *P. chrysocephala* dropped below the economic threshold and a H:P ratio of 4.1:1 was ascertained in the course of the season. In the remaining years of study, *T. tripartitus* occurred singly and the numbers of its host were economically insignificant.

Table IV. Parasitization of larvae of *Ceutorhynchus quadridens* by *Tersilochus obscurator* (n = 100)

Date	Locality	H:P ratio	No. larvae parasitized by *T. obscurator*
5.VI.55	Praha-Ruzyně*	73.4:1	27
30.V.56	Praha-Ruzyně	13.5:1	56
20.V.57	Praha-Ruzyně	1.6:1	82
12.V.66	Benešov		20
4.V.67	Benešov*		44
22.V.69	Benešov*		69
29.V.74	Benešov		6
19.V.75	Benešov*	48.3:1	39
14.V.76	Tachov		11
28.V.80	Nový Bor		30
30.V.	Tachov		9
22.V.81	Praha-Ruzyně	52.3:1	38
9.VI.	Slapy		21
27.V.82	Praha-Ruzyně		19
9.VI.	Slapy		18
4.VII.	Neveklov		25
4.VII.	Praha-Ruzyně	50.8:1	31
5.VII.	Tachov		12

*Occurrence of *Ceutorhynchus quadridens* above the economic level.

In winter rape fields larger than 50 ha the percentage of parasitized larvae of *Meligethes aeneus* decreased with increasing distance from the edges of the field. The degree of parasitization of the larvae was correlated with the decrease in the average number of larvae of *M. aeneus* per rape plant. The percentage of parasitized larvae was higher in a strip up to 25 m along the edges of the stand. At a distance of 50 m from the edge and deeper inside the stand the parasitization of the larvae was lower and almost did not vary. The effect of the higher parasitization at the edges of the stand was marked in fields at least 300 m broad (Table V).

In the suction trap, *Tersilochus heterocerus*, *T. obscurator* and *Phradis morionellus* were captured in May through July, 1982. *T. heterocerus* was the most abundant: in all, 1,458 specimens were captured. The flight activity of this species varied only slightly between 7 and 20 hrs. Occasional dispersal was recorded during the night. The sex ratio was 1 male : 1.2 females. The flight intensity of *Phradis morionellus* was somewhat weaker than in the foregoing species. In all, 974 specimens were captured. A rather high flight activity was recorded between 7 and 8 hrs whereupon it decreased gradually until 19 hrs. A single individual was found flying during night hours. The sex ratio was 1 male : 4.3 females. Compared to the two foregoing species, the flight activity of *Tersilochus obscurator* was the least intensive. Increased flight intensity was recorded between 7 and 8, 11 and 14, and 16 and 20 hrs. Occasional flying was recorded during night hours between 20 and 6 hrs (Fig. 2).

Table V. Percentages of parasitized larvae of *Meligethes aeneus* at different distances form the edge of the field.

Locality	Area of field, ha	Distance from edge, m					
		5	10	25	50	100	200
Benesov	60	94.-	96.4	69.4	43.-	39.2	36.-
Tachov	120	10.1	7.-	13.-	0.9		
Mochov	70	92.3	89.8	67.8	88.2	24.9	23.-
Duba	20	23.8	23.2	17.-	26.-	20.9	10.-
Popovice	10	71.3	70.-	70.8	70.8	61.2	60.5
Svetice	16	85.3	84.2	82.-	80.7	76.1	73.6

The first specimens of *P. morionellus* were present in the suction trap on 14 May, 1982. The numbers of this species increased rapidly and attained a peak on 25 May. The last specimens were obtained on 4 June. In a suction trap situated in a neighboring field of winter wheat, the last adults (both males and females) were captured as late as 24 June. In winter rape stands, *Tersilochus heterocerus* showed the longest period of occurrence. The first adults were captured in the suction trap on 16 May; the last ones, on 6 July; the peak numbers were recorded between 20 May and 4 June. The first adults of *Tersilochus obscurator* were ascertained in the winter rape stand on 25 May, the last ones on 24 June. Their increased occurrence was recorded on 1-4 June (Fig. 2). In all the above mentioned species the most numerous occurrence of adults coincides with the period at which their host larvae become full grown. Occasional adults of *T. heterocerus*, *T. obscurator* and *P. morionellus* were also captured in a suction trap situated in the neighboring winter wheat field. In that trap, most adults were captured between 11 June and 4 July; the greatest flight intensity was observed between 8 and 14 hrs.

In the yellow dishes only two ichneumon fly species parasitizing larvae of the insect pests of winter rape were captured during April through June, 1982. *Tersilochus heterocerus* was numerous; increased numbers were

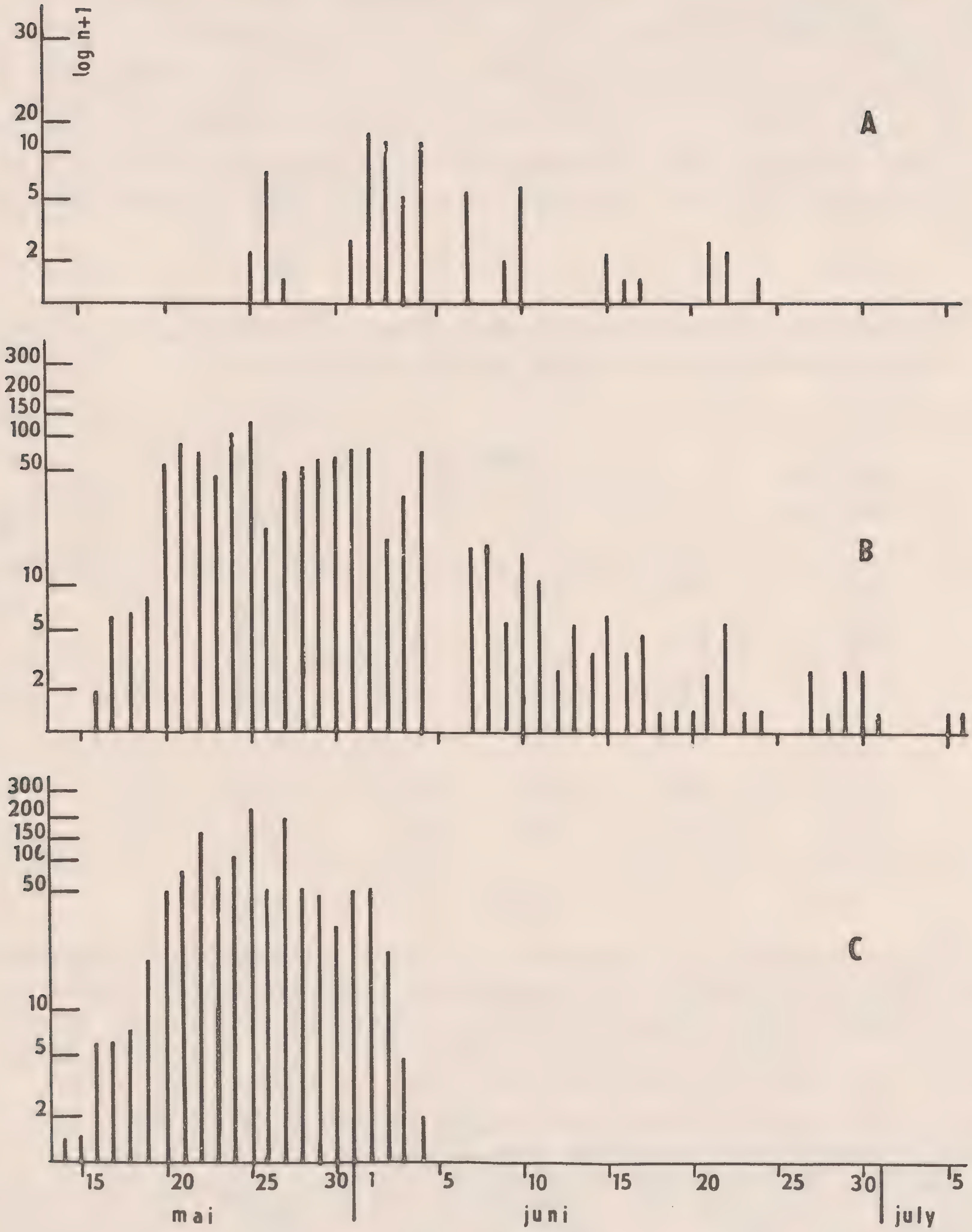

Fig. 2. Seasonal dynamics of the occurrence of ichneumon flies captured in the suction trap in 1982. A, **Tersilochus obscurator.** B, **T. heterocerus.** C, **Phradis morionellus.**

recorded on 15 - 18 and 24 - 30 May. In all, 416 adults were captured in six dishes, the observed sex ratio being 1 male : 0.7 females. *Phradis morionellus* was less numerous. Increased numbers of this species were observed on the same days as above. A total of 51 specimens was captured in the yellow dishes. Their sex ratio was 1 male : 1.1 females. No other Tersilochinae species were present in the catches in the yellow dishes.

DISCUSSION

The hitherto data on the period of occurrence and on the hosts of the ichneumon flies parasitizing insect pests of winter rape suggest that they are oligophaous and polyphagous species which mostly change habitats and hosts in the course of the growing season. Exceptions are provided by *Tersilochus fulvipes* and *T. tripartitus* whose adults occur within a rather short period in spring at which time also the larvae of their known hosts occur. In winter rape cultures, the abundance of species oriented to parasitize a single host species is more numerous in the year of the mass occurrence of their host and in the subsequent year. In years of low numbers of the hosts the occurrence of their parasitoids is mostly little numerous as well. The observed species parasitizing the pests of winter rape exerted little influence on the population dynamics of their hosts, except *Tersilochus fulvipes* which is considered an effective parasitoid of *Ceutorhynchus napi* (Balachowsky 1963). The percentage parasitization of larvae of this weevil was higher in years unfavorable for the embryonic and larval development of the host. The percentage parasitization increased in subsequent years and the retrogradation of *C. napi* deepened even under conditions favoring the development of the pest, for example in 1982.

The parasitization of the remaining pests was considerably variable and low. The peak numbers of the most abundant species, such as *Tersilochus heterocerus* and *Phradis morionellus*, were observed as late as during the period at which the winter rape ceased to flower and the host larvae had mostly left the plants to pupate in the soil. In such species the degree of parasitization varied considerably in different localities within one year. Apparently, the parasitization of the hosts depends on the intensity of dispersal of the ichneumon flies after hibernation. The electrical suction trap used in the study of the dispersal of adult ichneumon flies over winter rape stands was of only limited use, as it captured only insects flying on the level of the entrance opening. The trap is unsuitable for recording the occurrence of ichneumon flies moving within the stand. The suction trap mostly collected those species which parasitize *Meligethes* spp. whose larvae develop in the top parts of winter rape plants. The catches of *Tersilochus obscurator*, which species parasitizes larvae of *C. quadridens* developing in the tissues of winter rape stems, probably comprised adults which immigrated, or emigrated from, the winter rape stands. The number of ichneumon flies captured in a suction trap cannot be used to evaluate their numbers in a stand, as it only records their flight activity above the stand. The highest flight intensity was recorded during morning hours; the dispersal ceased during night hours.

The considerably different flight intensity of the ichneumon flies revealed by the suction traps placed in a winter rape and a winter wheat field suggests that the dispersal of the parasitoids was directed towards the host plants of their host species. What factors direct the dispersal of the ichneumon flies in search of their hosts cannot be judged from these observations. Townes (1972) believes the preference for certain ecological niches to be of decisive importance. From the low occurrence in, or virtual absence of certain ichneumon fly species from, the yellow dishes one may conclude that the yellow color of the flowering winter rape stands does not act as a visual attractant that would direct the dispersal of some of the ichneumon fly species.

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